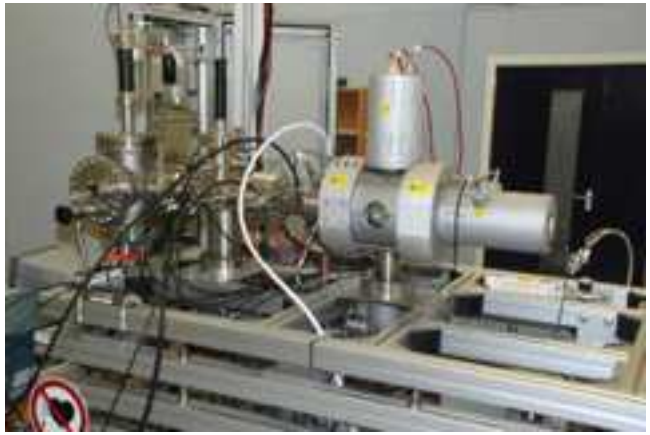
International Institute
for
Accelerator Applications

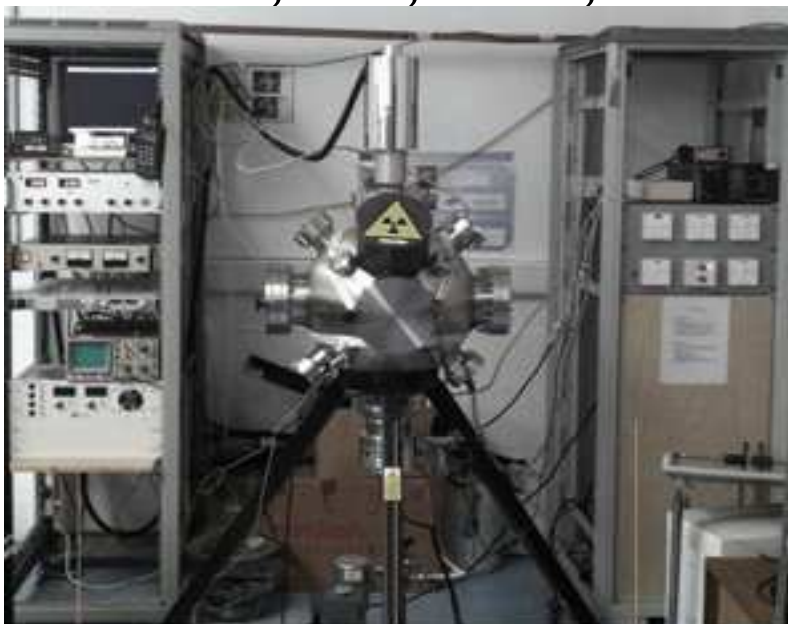
Photonics,and Particle Accelerators

Prof Rebecca Seviour
International Institute for Accelerator Applications
University of Huddersfield
UK

International Institute for Accelerator Applications
University of Huddersfield



- Group Founded 2011 (R. Barlow)
- 5 Faculty
- 2 Post docs
- 20 PG Students
- Siemens, TMD, Acceli, Kromek



- Medical isotope production
- ESS Targetry
- Security PFNA
- ADS (Transmutation/energy)
- LHC Collimation
- Transformative Electromagnetic Media
- Medium Energy Ion Scattering
- Ion Sources
- Novel RF

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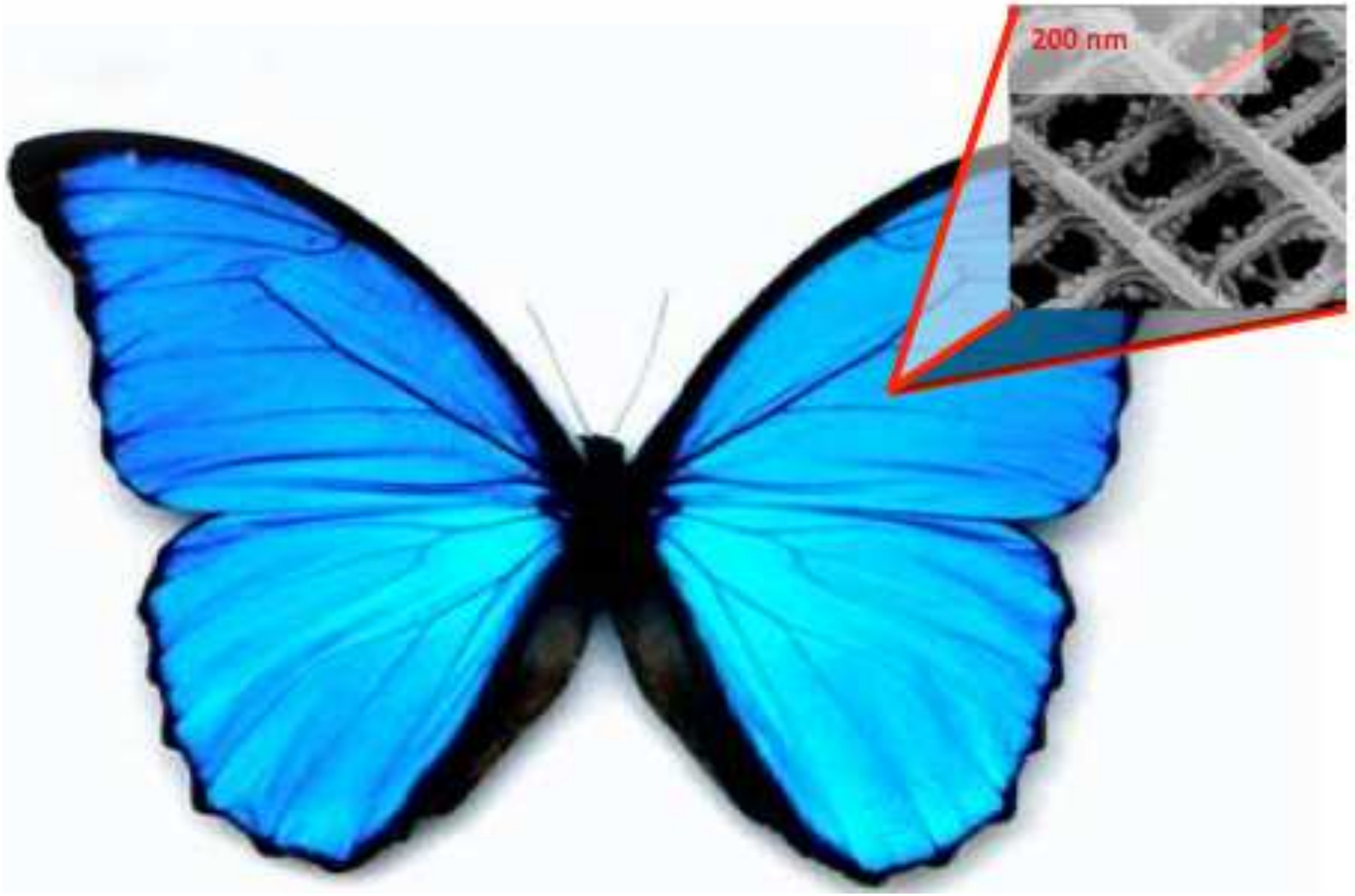
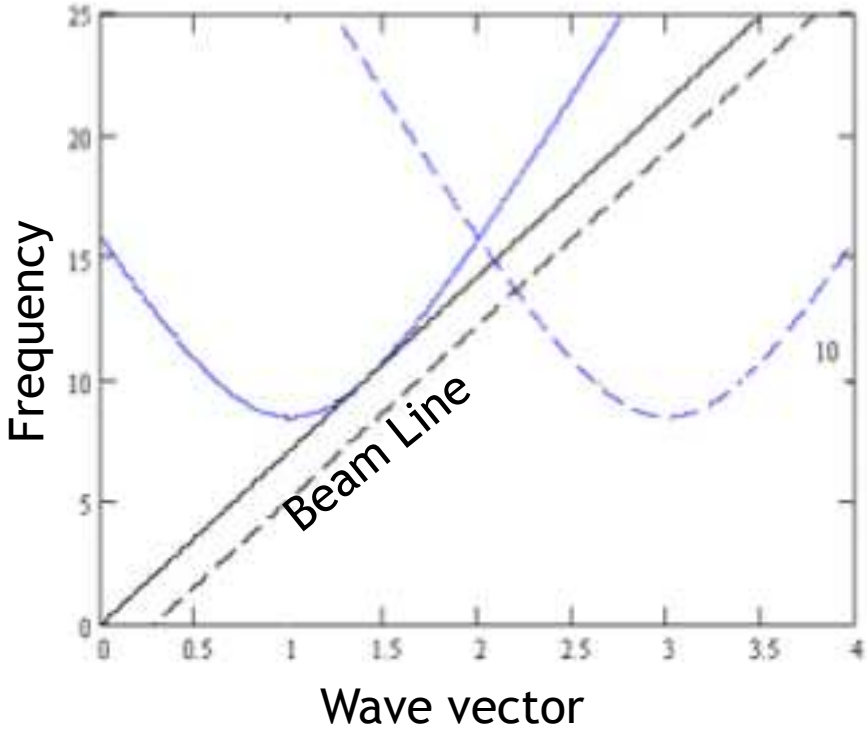
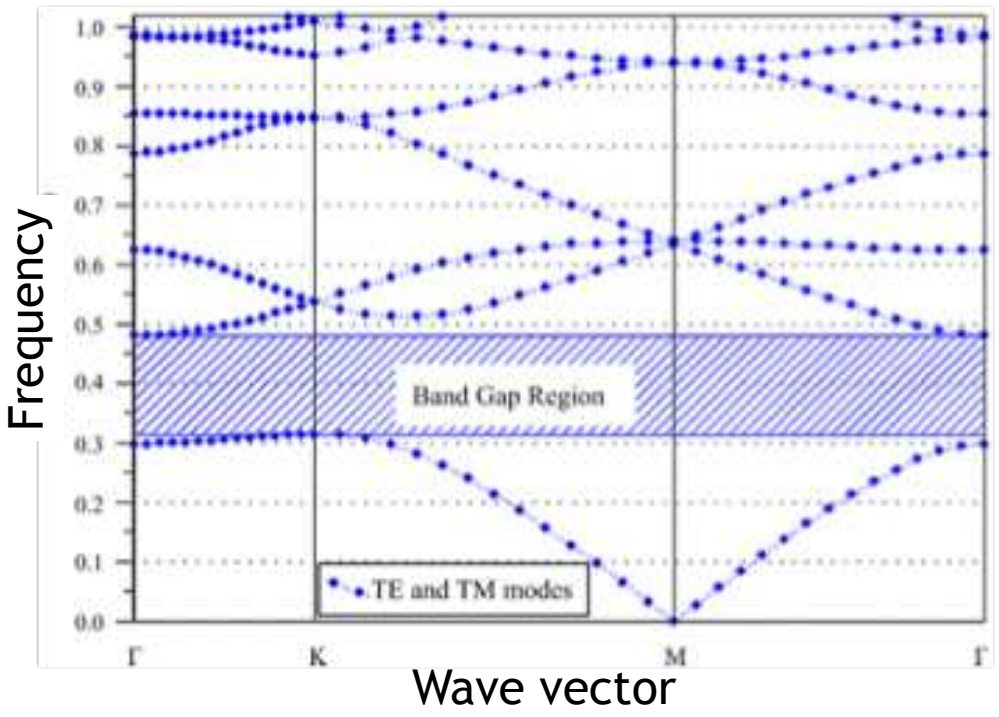
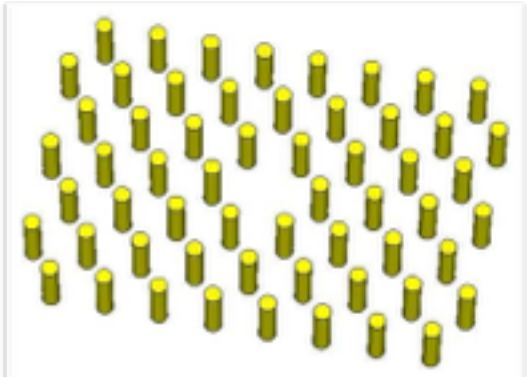
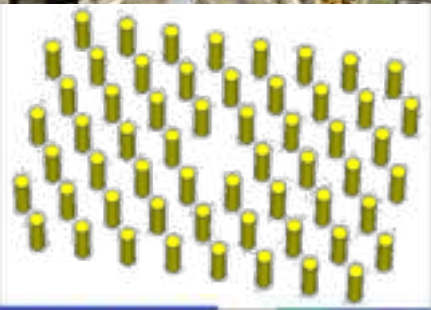
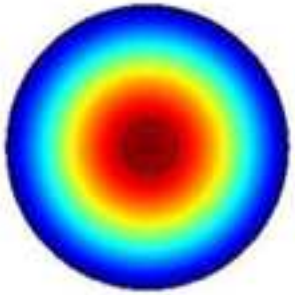



Frequency
Beam Line
Wave vector

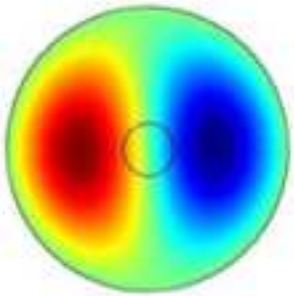

Frequency
Band Gap Region
TE and TM modes
Γ
K
M
Γ
Wave vector



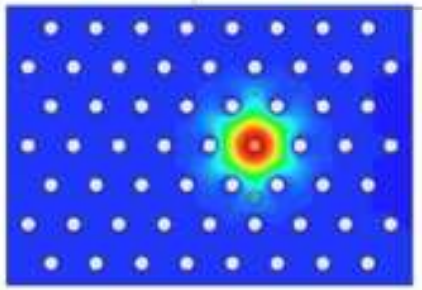




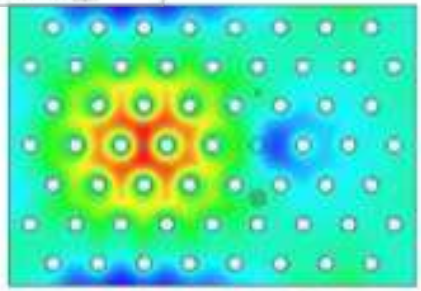
f_0 = 9.532 GHz
Q_{ohmic} = 3850



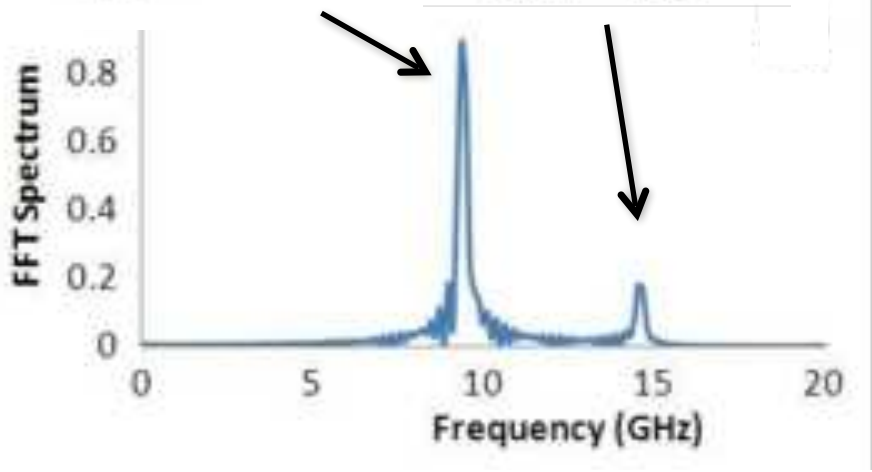
f_1 = 14.82 GHz
Q_{ohmic} = 4600

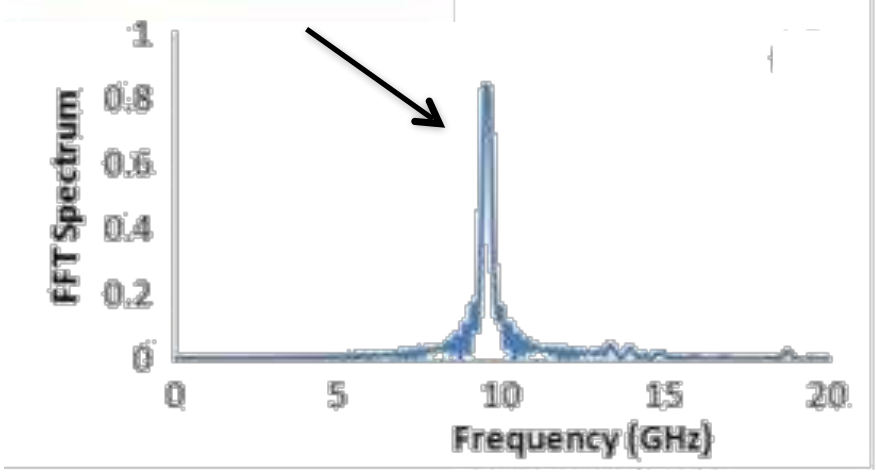


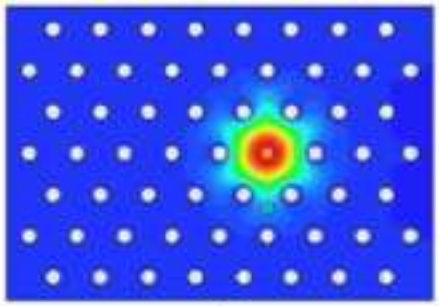
f_0 = 9.532 GHz
Q_{total} = 3200

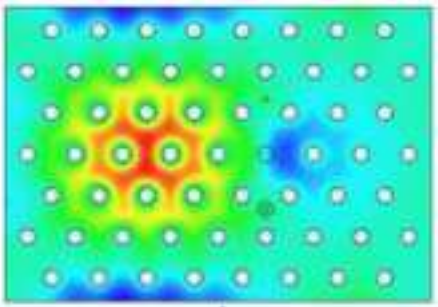


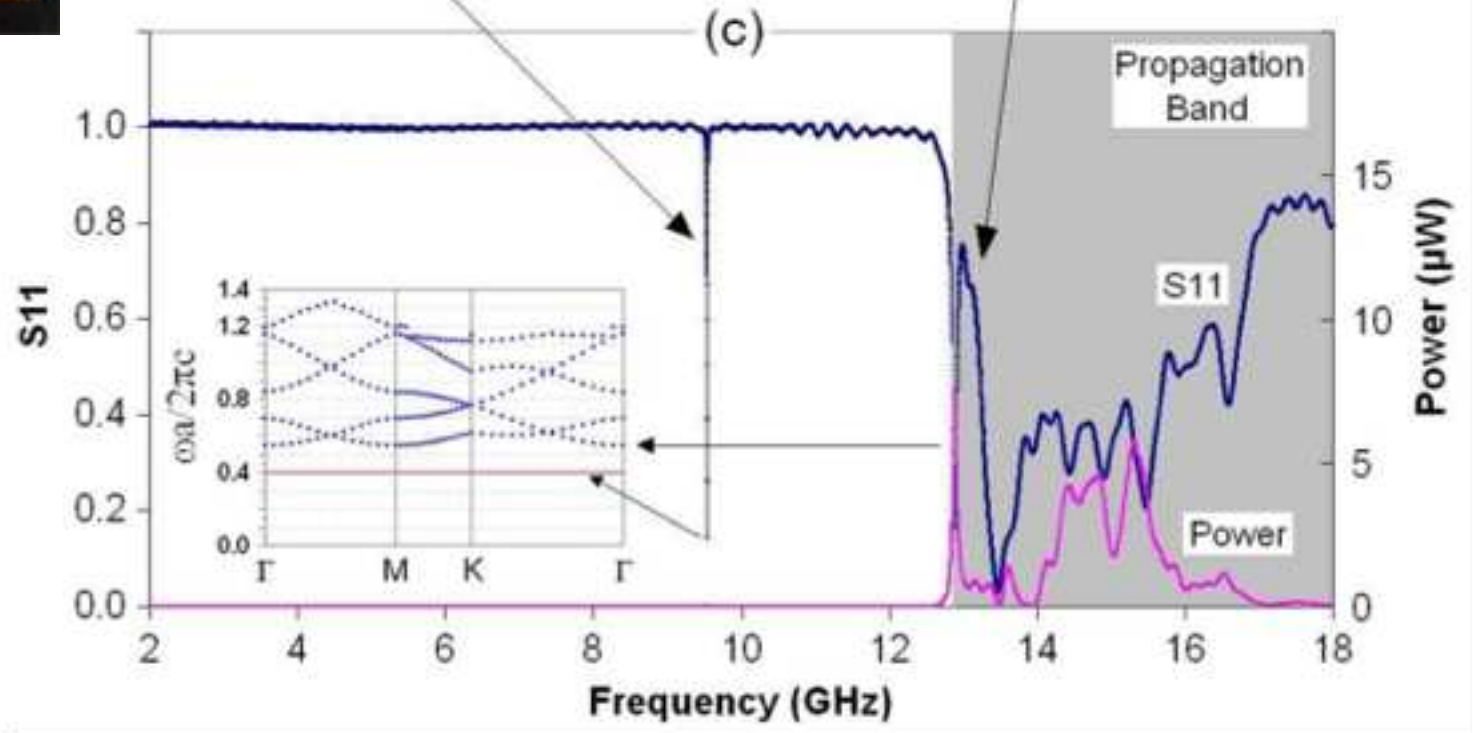
f_1 = 13.03 GHz
Q_{total} = 205



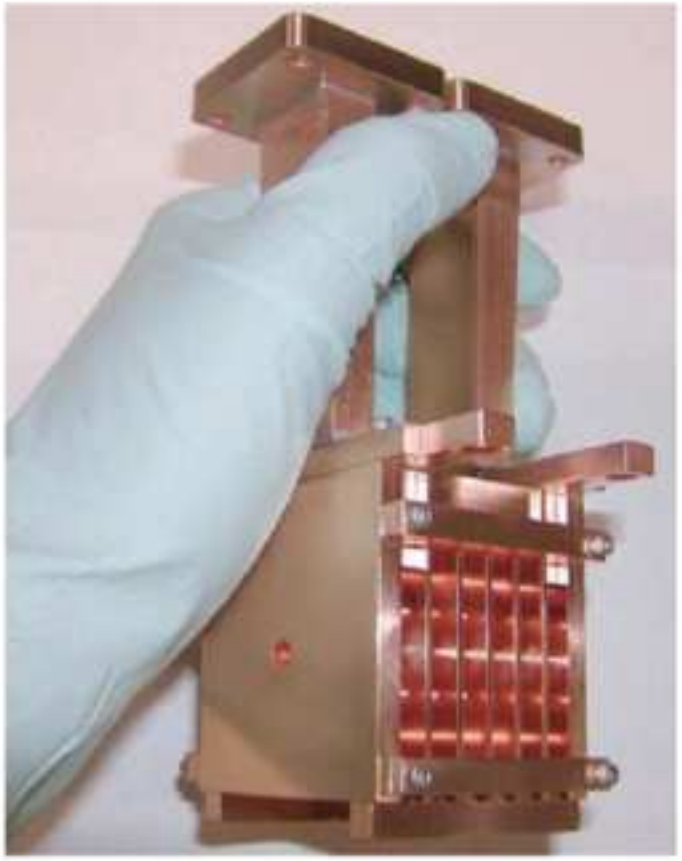




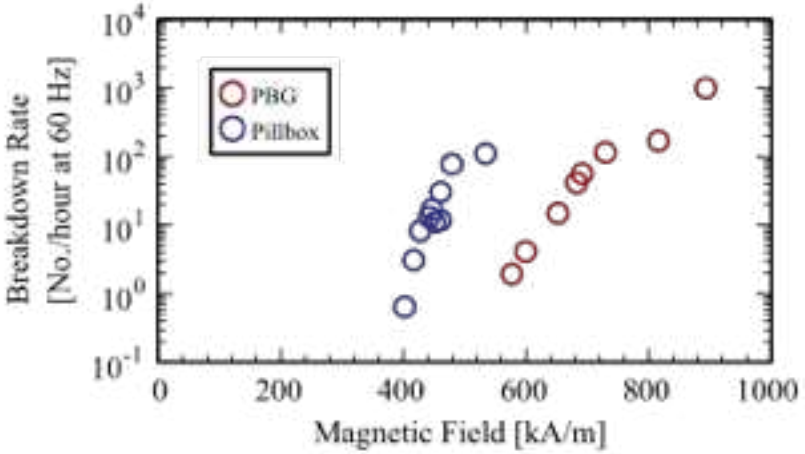


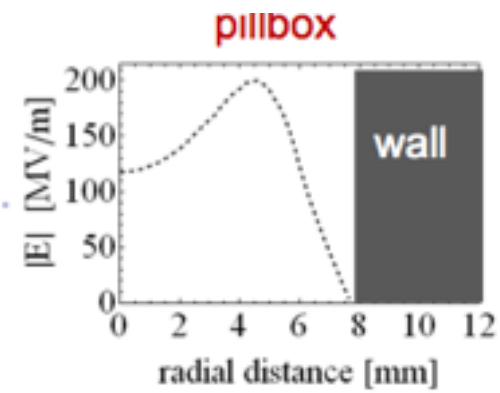

(c)
Propagation
Band
S11
Power
1.0
0.8
0.6
0.4
0.2
0.0
15
10
5
0
2
4
6
8
10
12
14
16
18
Frequency (GHz)
Power (μW)
ω/2πc
1.4
1.2
0.8
0.4
0.0
Γ
M
K
Γ

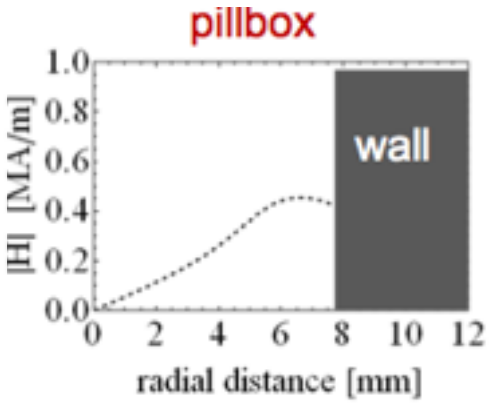
- Experimental results validate concept
- Demonstrated acceleration at 17 GHz at MIT (Smirnova 2005)
  - 35 MV/m achieved
- High-power testing at SLAC at 11 GHz (Marsh 2009)
  - 100 MV/m achieved
  - Showed influence of high H fields on breakdown

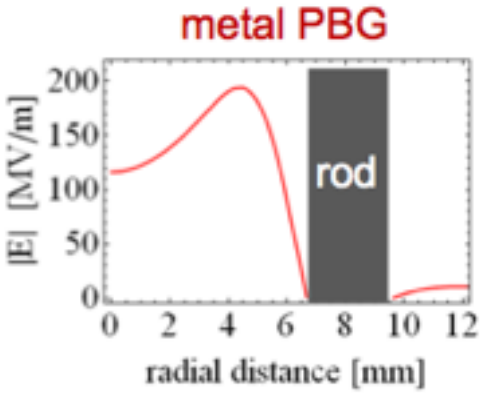


- E. I. Smirnova, A. S. Kesar, I. Mastovsky, M. A. Shapiro and R. J. Temkin,Phys. Rev. Lett., 95, 074801, 2005
- R. A. Marsh, M. A. Shapiro, R. J. Temkin, E. I. Smirnova and J. F. DeFord, Nucl. Instrum. Methods Phys. Res., Sect. A 618, 16, 2010.









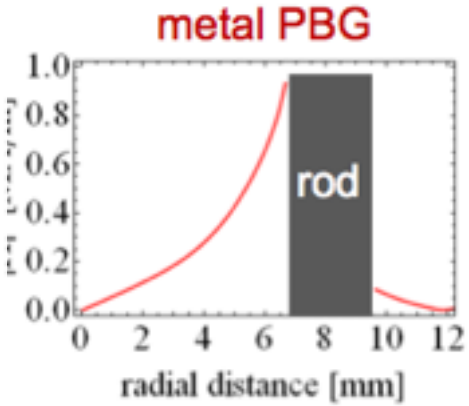
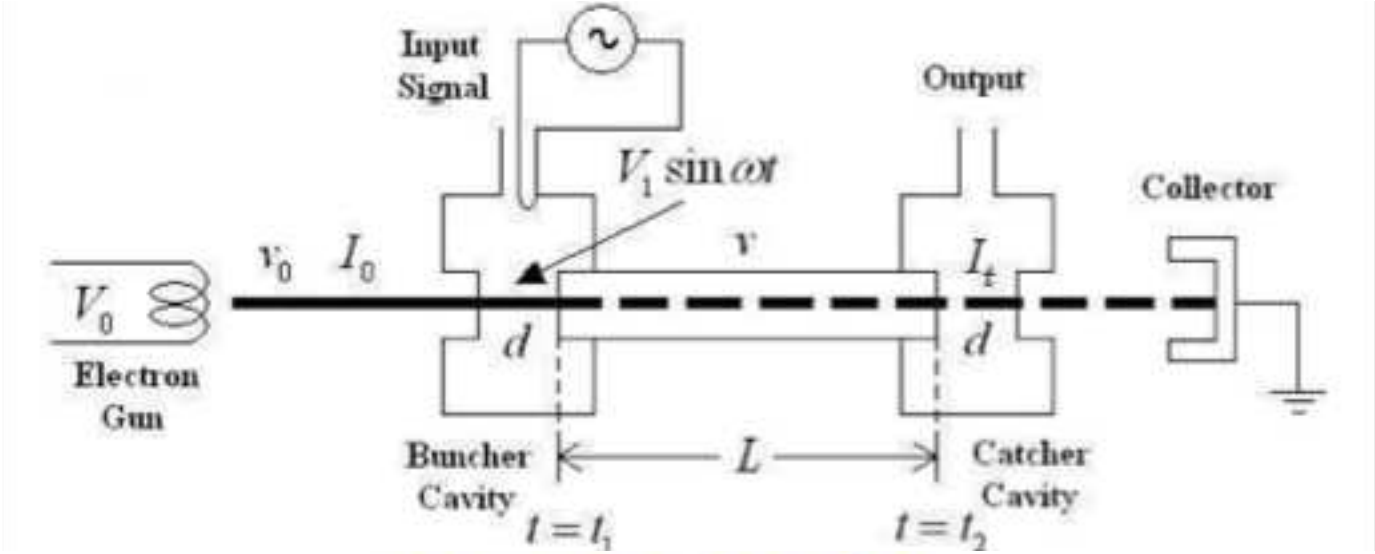
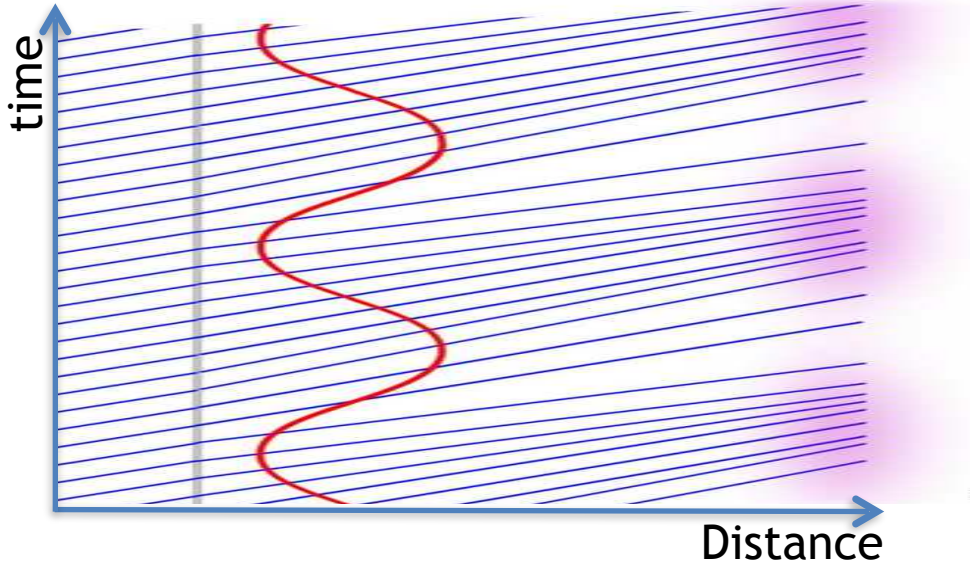
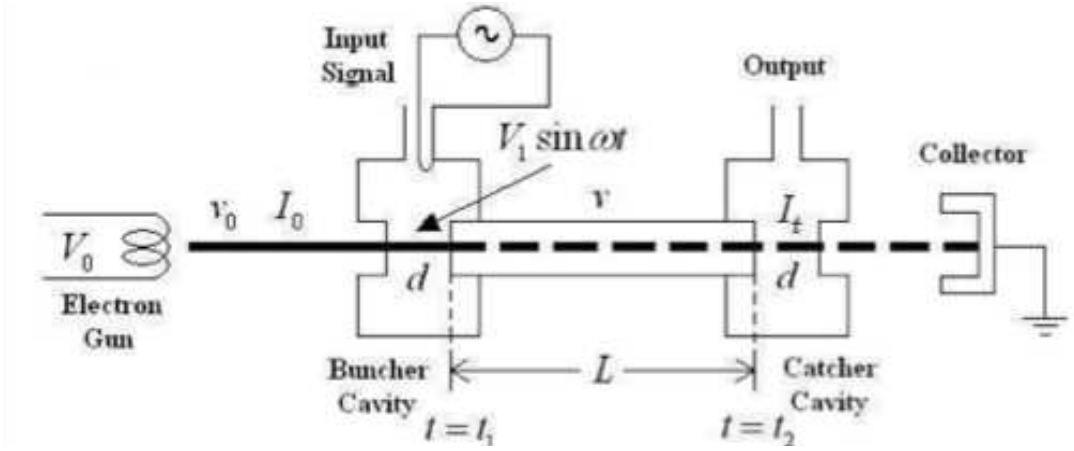


FIG. 18. PBG and pillbox breakdown rate vs maximum surface magnetic field for 170 ns pulse length.

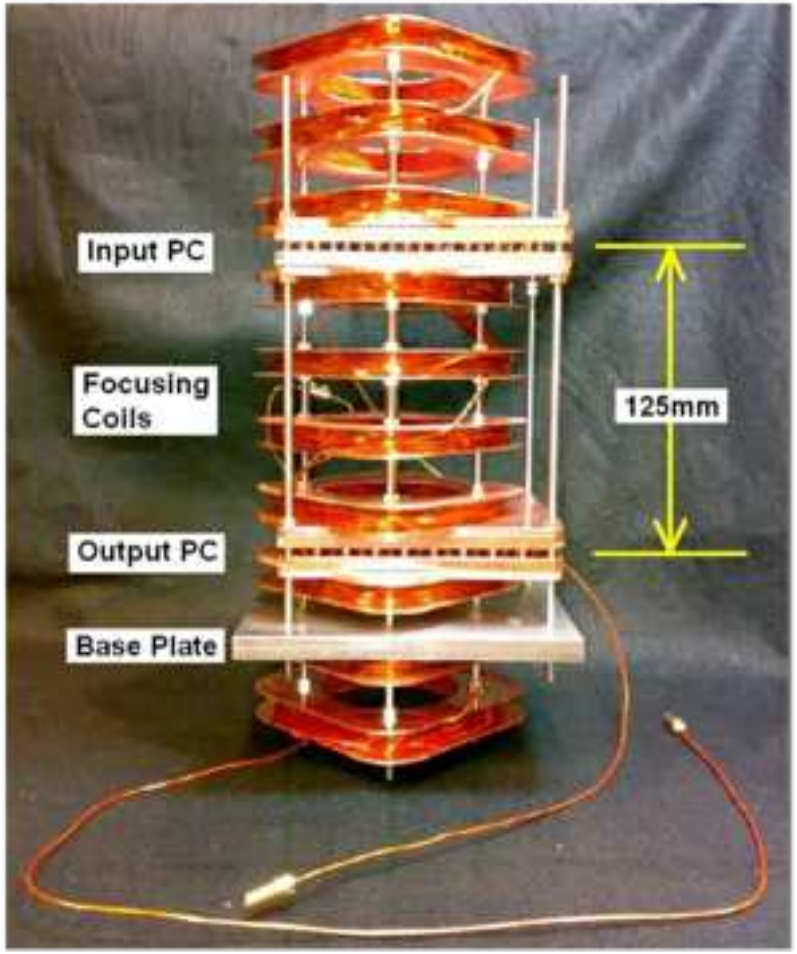


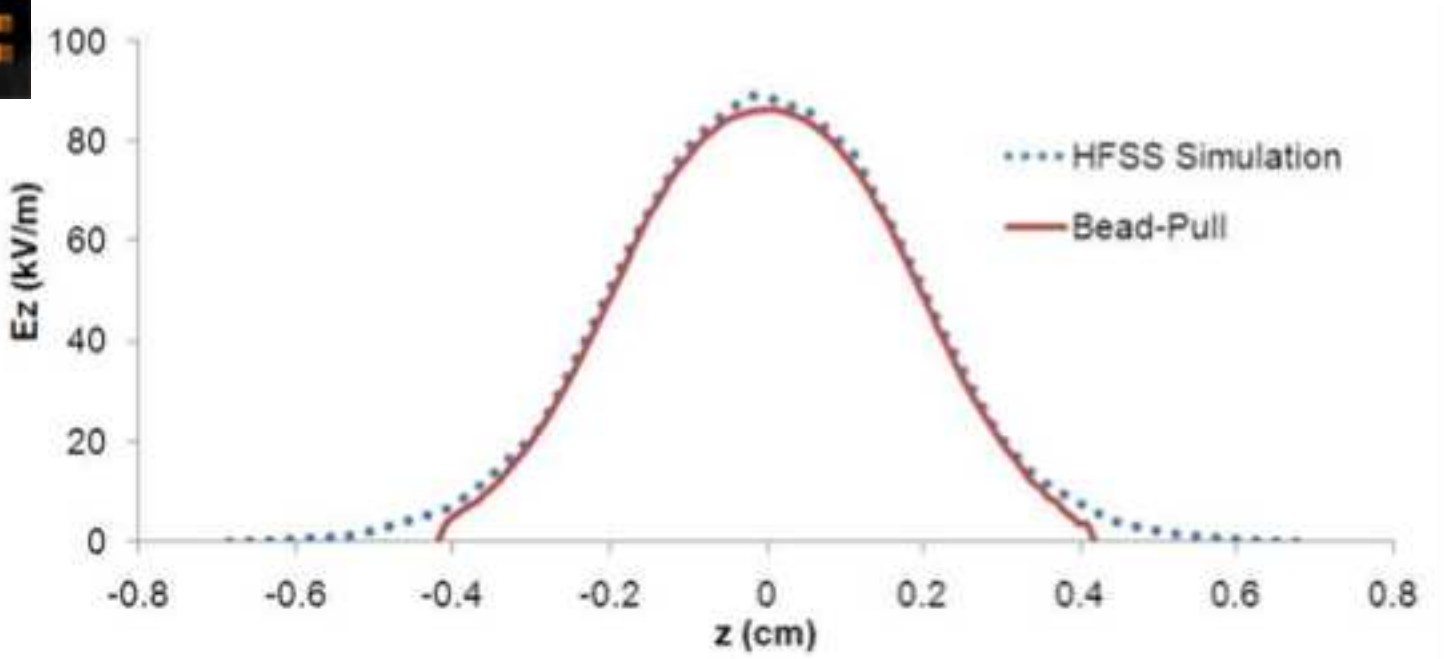


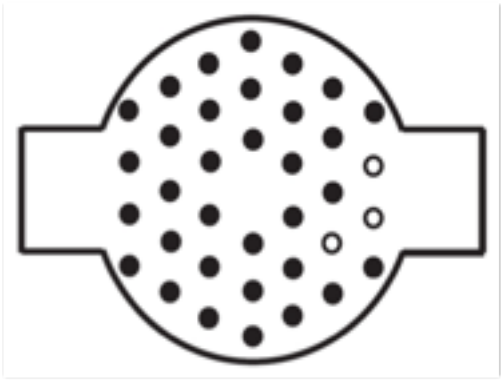


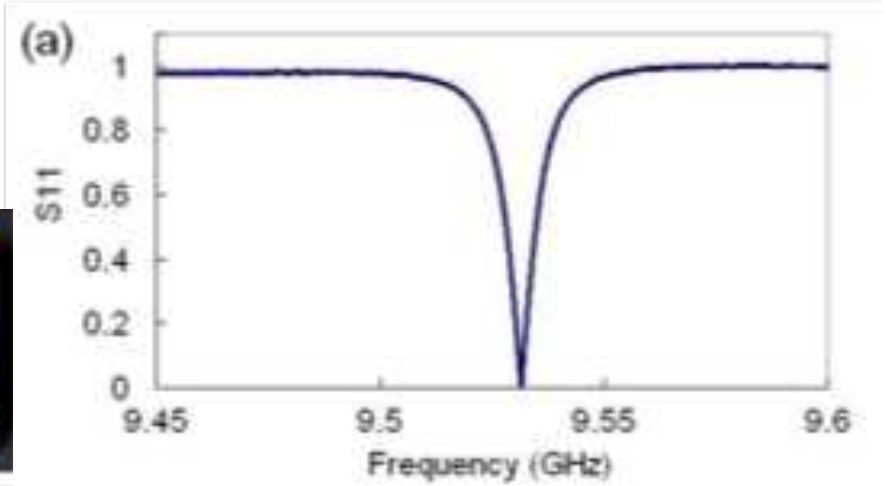
Xu and Seviour 2012 *New J. Phys.* **14** 013014

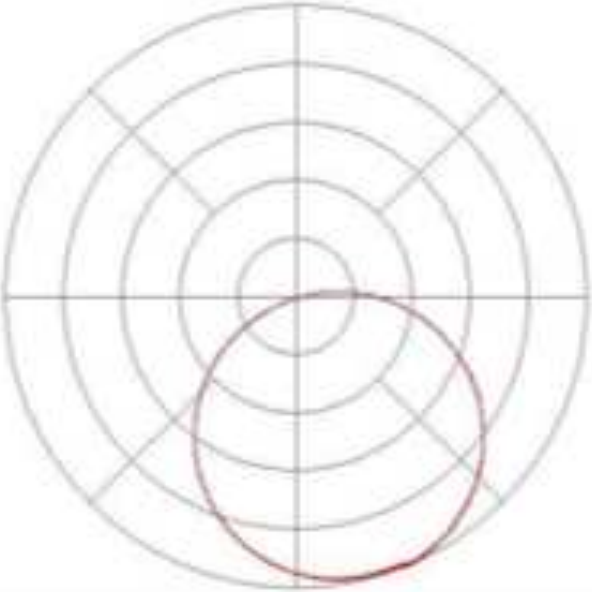
Parameters	input PC	output PC
Rod radius (r)	.995± 0.005 mm	2.013± 0.01 mm
Rod spacing (a)	2.50 mm 1	12.52 mm
Lattice depth (d)	.6 mm 3	3.3 mm
Beam hole diameter	4 mm	4 mm
Measured resonant freq.	9.532 GHz	9.532 GHz
S11	0.004	0.135
Propagation band	12.95 GHz	12.94 GHz
Q_L (Loaded Q)	820	780
Q_e (External Q)	1640	1382
Q_0 (Unloaded/ Ohmic Q)	1640	1790
Shunt impedance (R_{sh})	47 70 Ω	81190 Ω
R_{sh}/Q_0	45.55 Ω	45.36 Ω

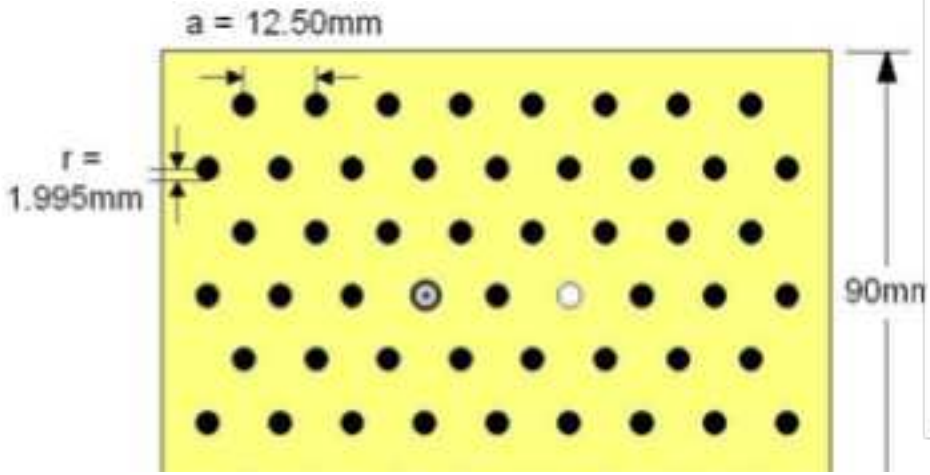


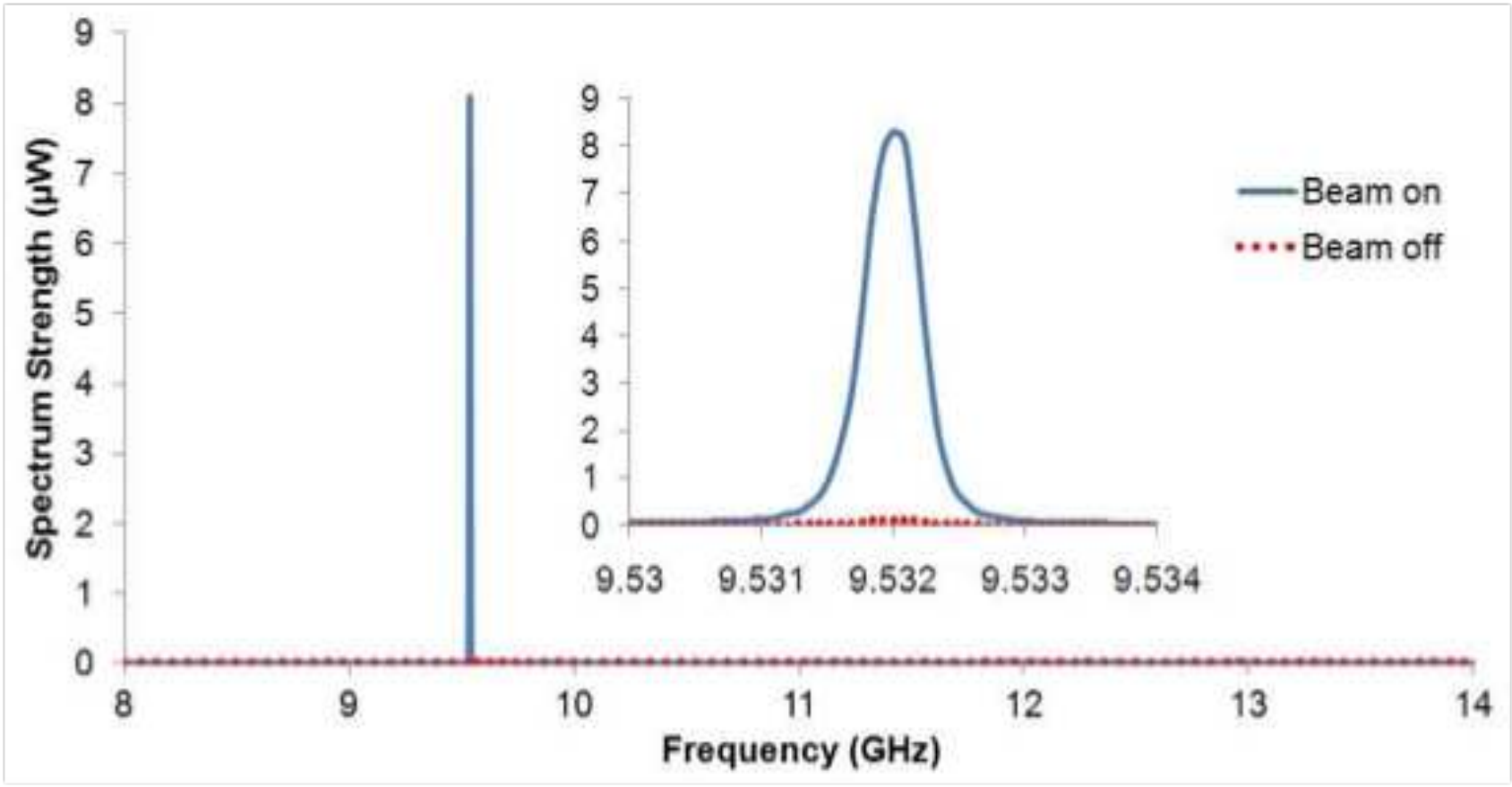

100
80
60
40
20
0
Ez (kV/m)
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
z (cm)
HFSS Simulation
Bead-Pull



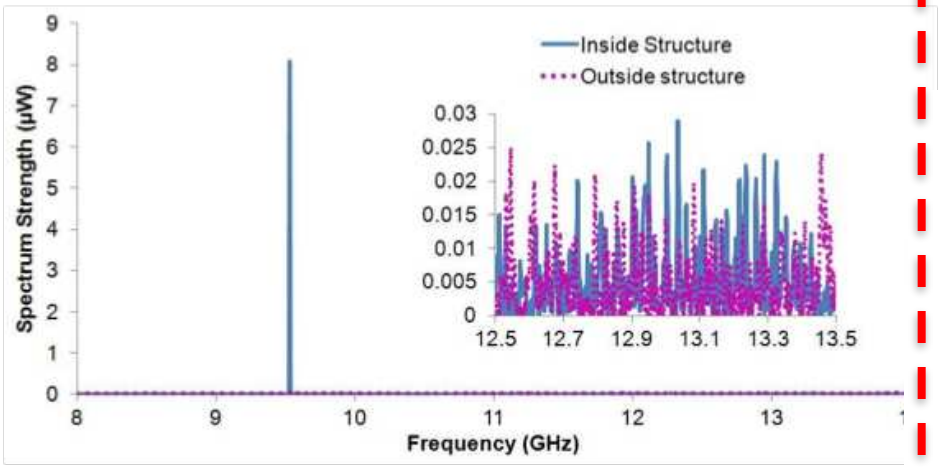

(a)
S11
1
0.8
0.6
0.4
0.2
0
9.45
9.5
9.55
9.6
Frequency (GHz)

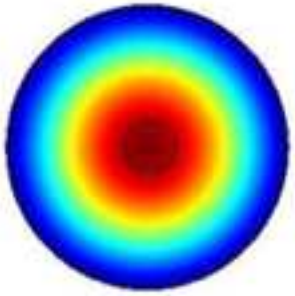



a = 12.50mm
r =
1.995mm
90mm

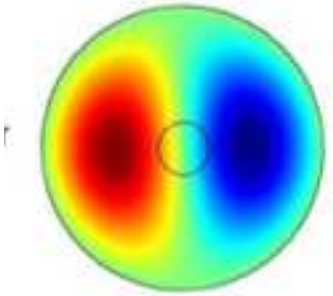

Spectrum Strength (μW)
Frequency (GHz)
Beam on
Beam off
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
9.53
9.531
9.532
9.533
9.534

Inside Structure
Outside structure
Spectrum Strength (μW)
Frequency (GHz)
0
1
2
3
4
5
6
7
8
9
8
9
10
11
12
13
14
0
0.005
0.01
0.015
0.02
0.025
0.03
12.5
12.7
12.9
13.1
13.3
13.5

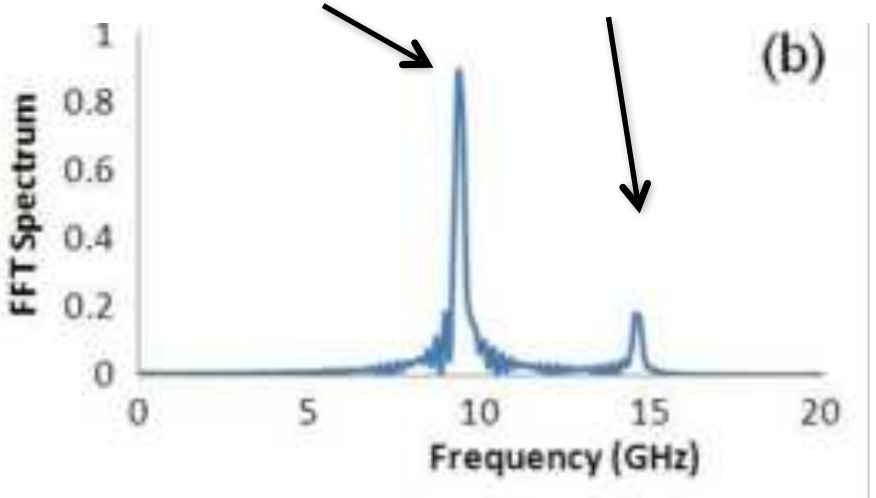




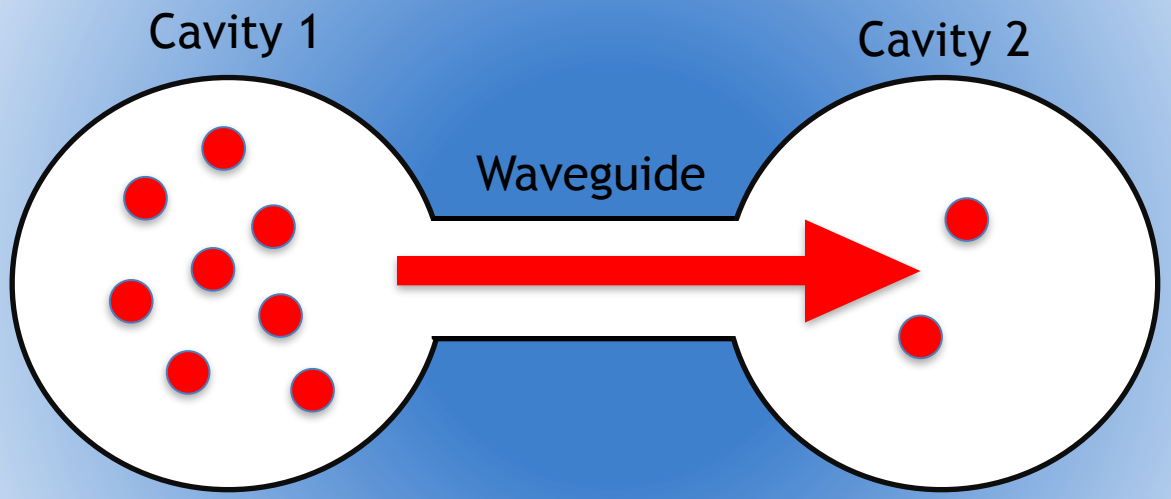
f_0 = 9.532 GHz
Q_{ohmic} = 3850



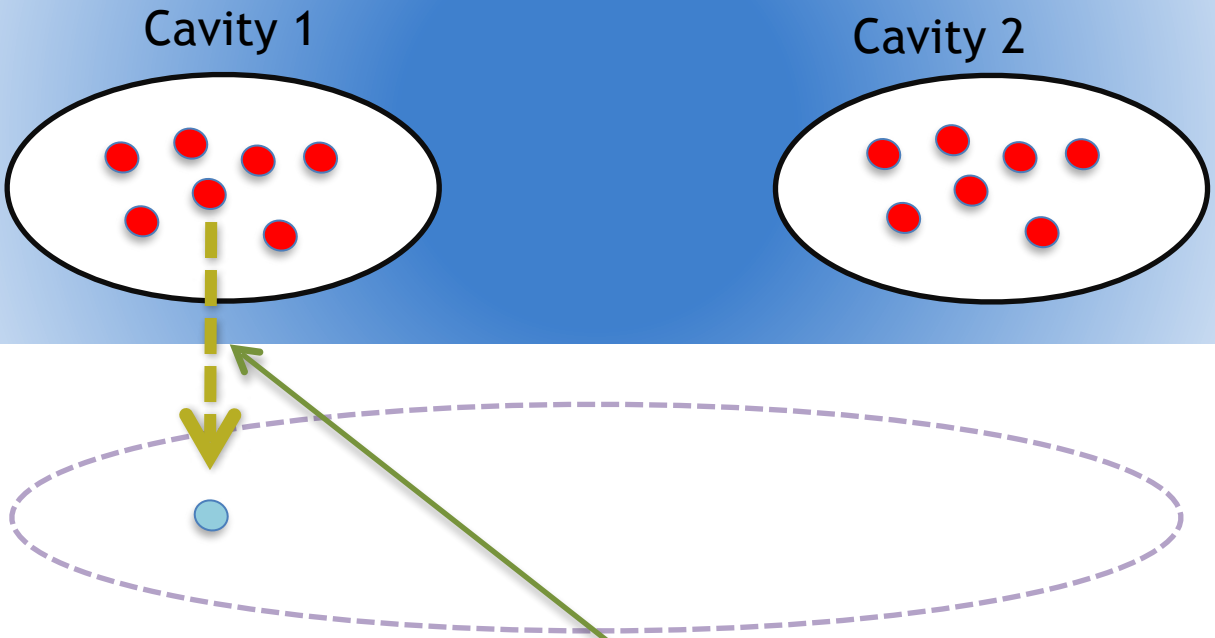
f_1 = 14.82 GHz
Q_{ohmic} = 4600



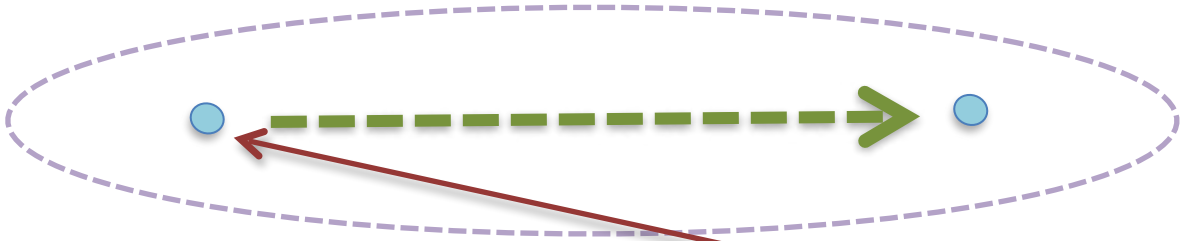
Hidden Sector Photon Searches



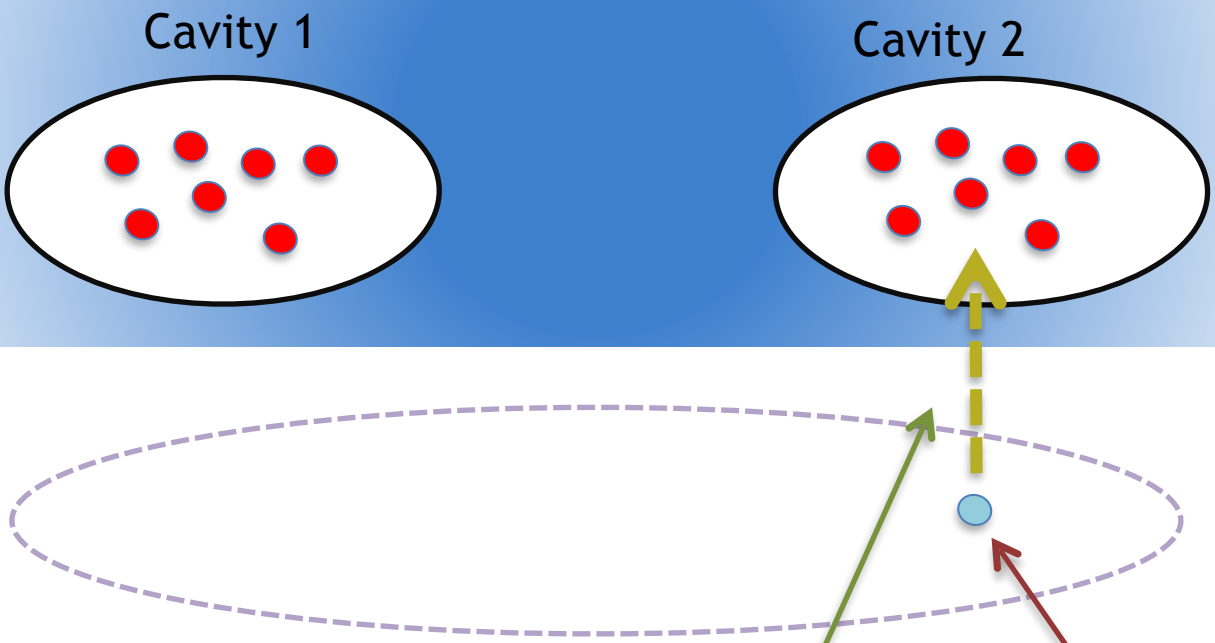
$$\nabla^2 E - \mu\varepsilon_r\varepsilon_0\omega^2 \frac{\partial^2 E}{\partial t^2} = 0$$



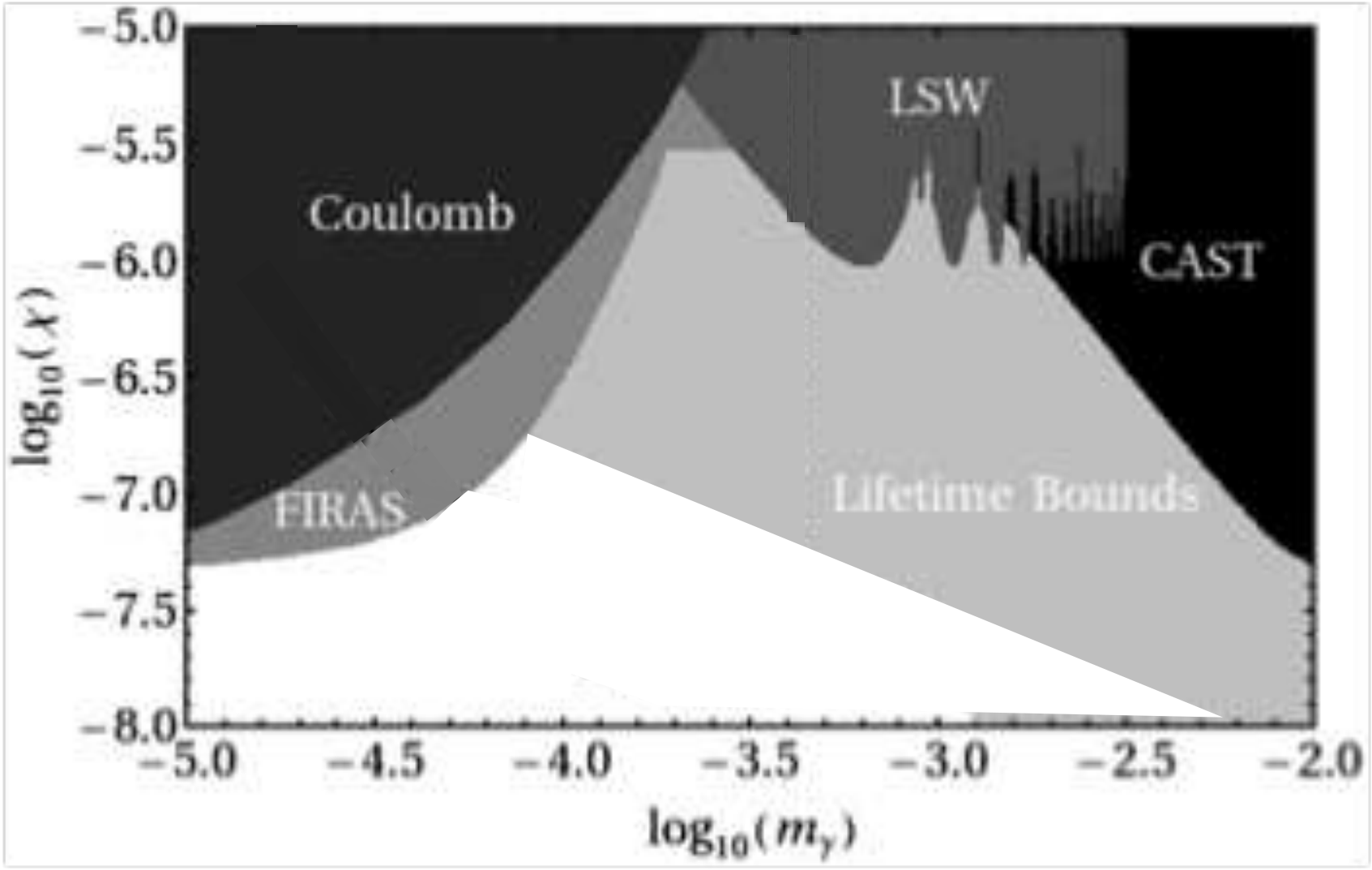
$$\mathcal{L} = -\frac{1}{4}F^{\mu\nu}F_{\mu\nu} - \frac{1}{4}B^{\mu\nu}B_{\mu\nu} - \frac{\chi}{2}F^{\mu\nu}B_{\mu\nu} + \frac{m_\gamma^2}{2}B^\mu B_\mu$$



$$\mathcal{L} = -\frac{1}{4}F^{\mu\nu}F_{\mu\nu} - \frac{1}{4}B^{\mu\nu}B_{\mu\nu} - \frac{\chi}{2}F^{\mu\nu}B_{\mu\nu} + \frac{m_\gamma^2}{2}B^\mu B_\mu$$



$$\mathcal{L} = -\frac{1}{4}F^{\mu\nu}F_{\mu\nu} - \frac{1}{4}B^{\mu\nu}B_{\mu\nu} - \frac{\chi}{2}F^{\mu\nu}B_{\mu\nu} + \frac{m_\gamma^2}{2}B^\mu B_\mu$$


LSW
Coulomb
CAST
FIRAS
Lifetime Bounds
−5.0
−5.5
−6.0
−6.5
−7.0
−7.5
−8.0
log10(χ)
−5.0
−4.5
−4.0
−3.5
−3.0
−2.5
−2.0
log10(my)

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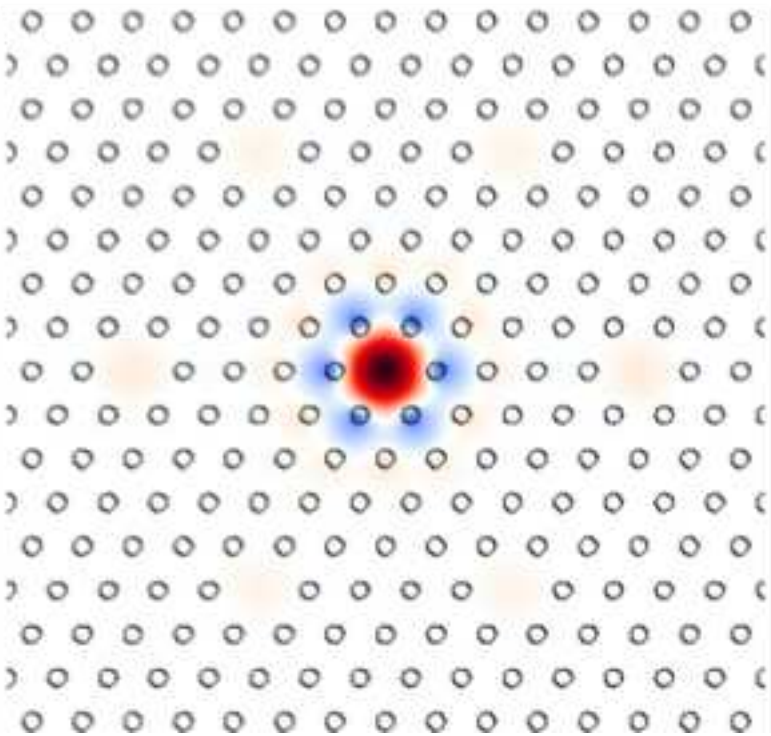
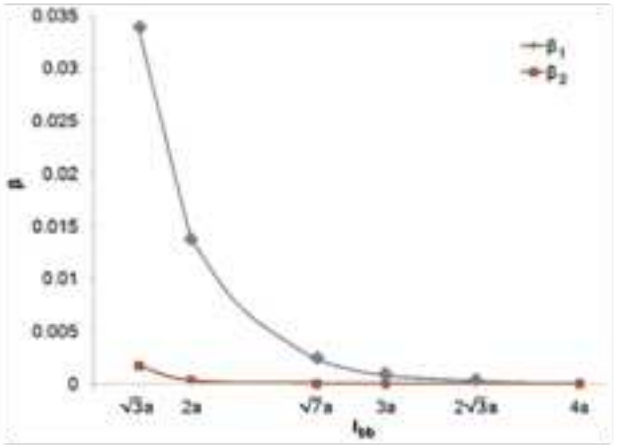
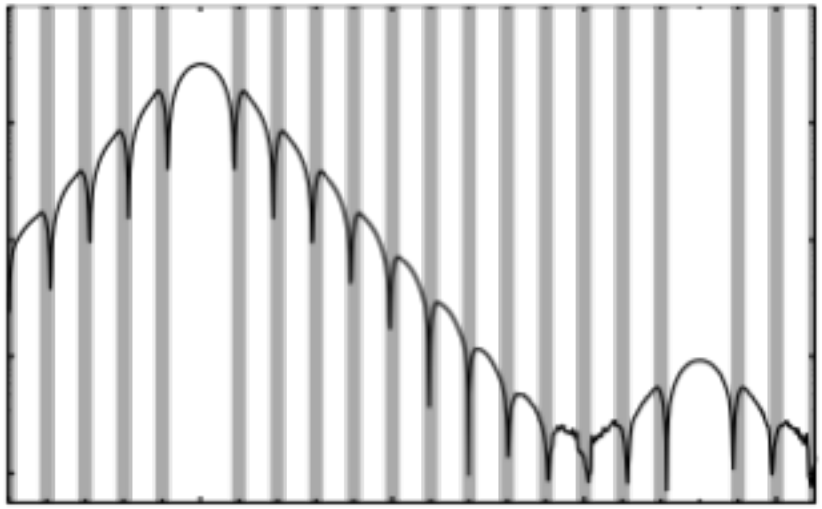
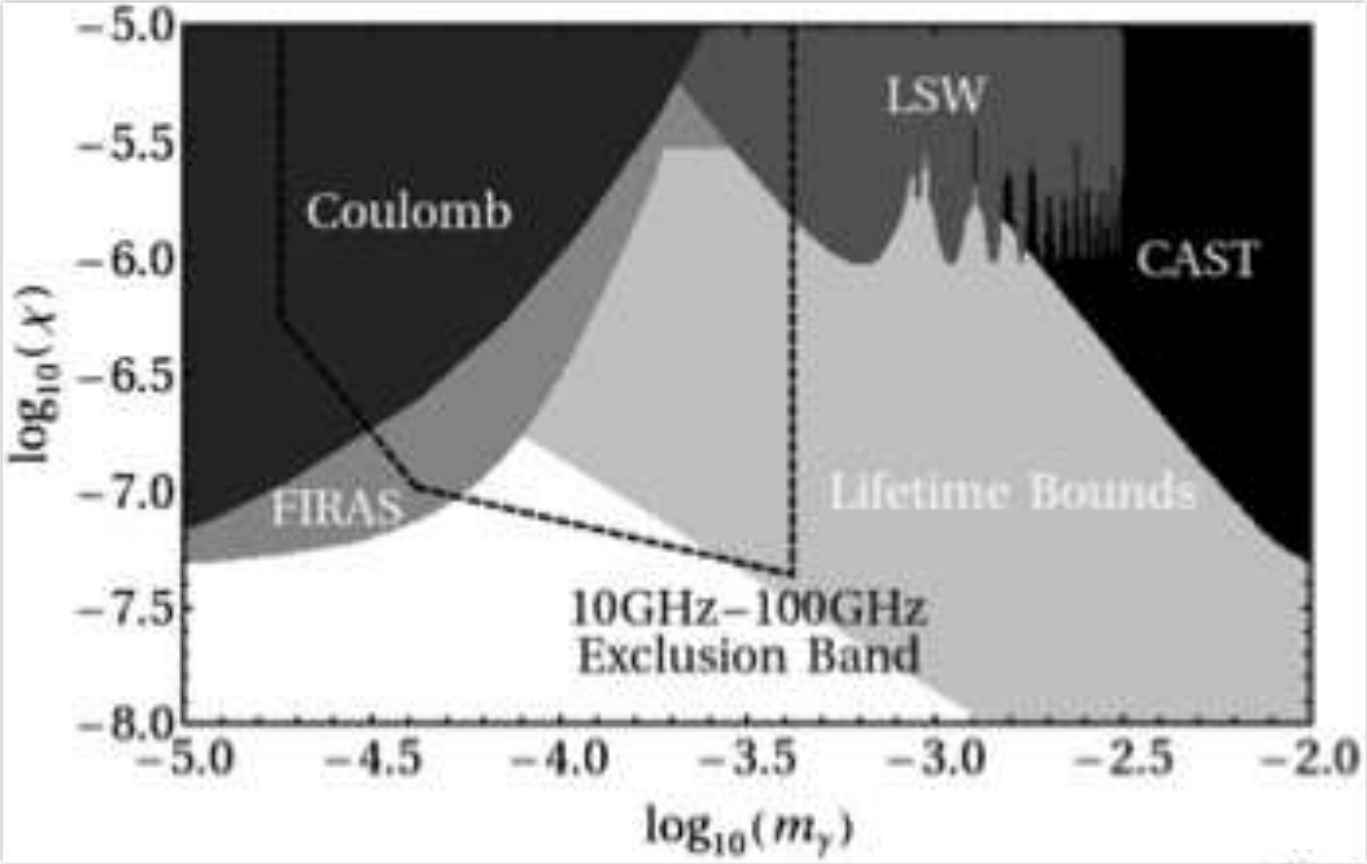






J. Phys. G: Nucl. Part. Phys. **41** (2014) 035005



$$\mathcal{L} = -\frac{1}{4}F^{\mu\nu}F_{\mu\nu} - \frac{1}{4}B^{\mu\nu}B_{\mu\nu} - \frac{\chi}{2}F^{\mu\nu}B_{\mu\nu} + \frac{m_\gamma^2}{2}B^{\mu}B_{\mu}$$

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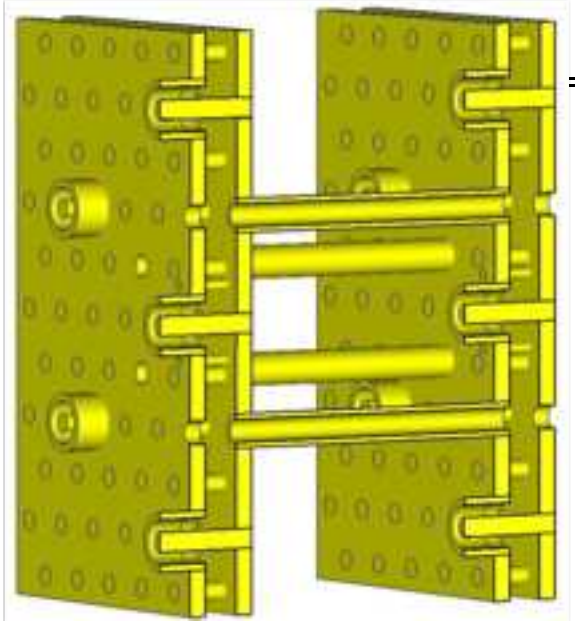
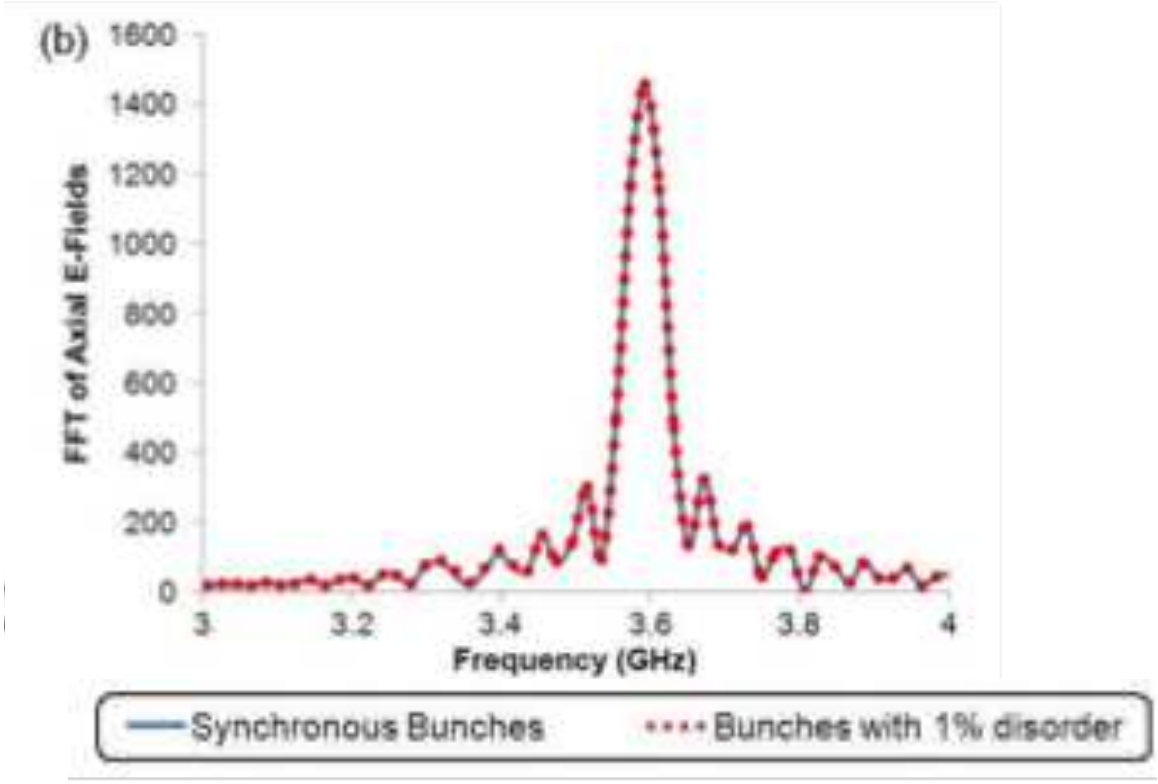
Multi-Beam Kylstron/Accelerator

V_0 (DC beam voltage)	100 kV
I_0 (DC beam current)	2 A
r_b (Beam radius)	5 mm

Parameters	1 beam (AJ Disk)	6 beams (Scaled)
Input power, P_{in} (W)	16.67	100
Output power, P_{out} (kW)	5.54	33.24
Drift distance, L (m)	0.62	0.62
Power gain, (dB)	25.22	25.22
Output voltage, V_{out} (kV)	42.55	42.55
Magnetic focusing field, B (Tesla)	0.8	0.8




(b)
1600
1400
1200
1000
800
600
400
200
0
FFT of Axial E-Fields
3
3.2
3.4
3.6
3.8
4
Frequency (GHz)
Synchronous Bunches
Bunches with 1% disorder

Dielectric Structure

Masullo et al. *Microwave Opt. Tech. Lett.* 2006

Frequency		E I to C axis	
		DielectricConstant	Loss Tangent
1 MHz		9.39	0.0001

Table 3
Difference of $\tan\delta$ from the standard value of $\tan\delta_0$ at 30 K

Growth method	Frequency (GHz)	Mode	Sample name	$\Delta\tan\delta$ ($\times 10^{-7}$)
EFG	12	011	EFG12G011A	0.95
			EFG12G011B	0.72
		013	EFG12G013A	0.29
			EFG12G013B	0.47
			EFG12G013C	0.93
			EFG12G013D	0.38
	22	011	EFG22G011A	0.00
		013	EFG22G013A	0.91

Thank You !!!!